Management of diabetic ketoacidosis in adults (age 16 years and over)

Protocol use
This protocol is to be used for the management of diabetic ketoacidosis (DKA) in adults over the age of 16.
This protocol is NOT to be used for the treatment of:
- Hyperglycaemic hyperosmolar state
- The management of DKA in an intensive care unit

Clinical signs and symptoms
- Hyperventilation
- Dehydration
- Abdominal pain +/- vomiting
- Impaired consciousness

ICU consultation
Refer to ICU for consultation (if any of the following)
- pH < 7.1
- Altered level of consciousness
- Severe hypokalemia (< 3mmol/L)
- Severe hyponatremia (< 125mmol/L)
- Altered blood pressure/severe dehydration
- Pregnancy

Key issues
- Initial fluid management
- Early potassium (K⁺) replacement
- Early IV insulin initiation (titrated to blood glucose level [BGL])
- Frequent monitoring

POTASSIUM REPLACEMENT GUIDELINES
All infusions containing potassium must be given via an infusion pump or burette.
Maximum concentration = 40mmol/L peripherally to prevent phlebitis.
Exception: isotonic, premixed potassium chloride 10mmol/100mL minibags (commercially premade, ready to use) can be given peripherally. Note: Minibags must be given via an infusion pump.
Maximum rate:
- With burette = 10mmol/hr
- With infusion pump = 20mmol/hr
If maximum rates or concentration are exceeded, cardiac monitoring in a high acuity bed, as well as administration through a large vein with high blood flow (eg. CVC, venous access port, PICC) is required.
For further information on potassium replacement please refer to you local prescribing guidelines.

WARNING
Diabetic ketoacidosis carries a significant mortality rate and close monitoring is essential.
IF THERE IS A SUSPICION OF CEREBRAL OEDEMA OR THE PATIENT IS NOT IMPROVING CALL A CONSULTANT.
Signs of cerebral oedema (see page 4) should be monitored throughout the first 24 hours.
This clinical protocol is a general guide and does not replace clinical judgement.

Care should be individualised to meet the specific needs of each patient.

Immediate management – ‘hour 1’

<table>
<thead>
<tr>
<th>Step 1 – initial investigation</th>
<th>Ongoing management – ‘hour 2 – 4’</th>
<th>Subsequent management</th>
<th>Discharge planning</th>
</tr>
</thead>
<tbody>
<tr>
<td>Two IV cannulae</td>
<td>Hourly BGL</td>
<td>Hourly BGL until IV insulin infusion ceased</td>
<td>Step 1 – refer for specialist review before discharge</td>
</tr>
<tr>
<td>FBE, U&amp;E, LFT, BGL, venous blood gas (VBG)</td>
<td>Finger pricking ketones at triage and end of ‘hour 1’</td>
<td>U&amp;Es and VBG at end of ‘hour 2’ and ‘hour 4’</td>
<td>Refer to specialist to determine: cause of DKA episode, need for diabetes education and review of knowledge and understanding of condition.</td>
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<tr>
<td>finger pricking ketones at triage and end of ‘hour 1’</td>
<td>Blood cultures</td>
<td>Finger pricking ketones (q4h)</td>
<td></td>
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<tr>
<td>Blood cultures</td>
<td>If indicated/not checked already:</td>
<td>Hourly fluid balance chart (catheter if oliguric)</td>
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<tr>
<td>Step 2 – fluid replacement (cannula 1)</td>
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<tr>
<td>0.9% sodium chloride 1000mL/hr. Repeat if hypotensive (systolic BP &lt; 100)</td>
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<tr>
<td>Step 3 – start IV insulin (cannula 2)</td>
<td>Continue 0.9% sodium chloride</td>
<td>Continue K+ replacement to maintain within reference range and continue to monitor K+ as above with U&amp;Es and VBG</td>
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<tr>
<td>If K+ &gt; 3.0mmol/L, commence soluble insulin intravenously at 0.1unit/kg/hr (maximum starting dose 10 units/hr)</td>
<td>500mL/hr for ‘hour 2’</td>
<td>Continue insulin at variable rate to maintain BGL 9-14mmol/L. It is likely that the rate will need to be decreased at this point to maintain 9-14mmol/L</td>
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<tr>
<td>If K+ &lt; 3.0mmol/L, replace K+ (cannula 1), recheck levels and commence insulin infusion once K+ &gt; 3.0mmol/L</td>
<td>500mL/hr for ‘hour 3’</td>
<td>When BGL &lt; 14mmol/L give 10% glucose 100mL/hr via ‘Y’ site (cannula 2) and review insulin infusion rate to maintain BGL 9-14mmol/L. Continue 0.9% sodium chloride fluid resuscitation as above</td>
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<tr>
<td>Step 4 – other actions</td>
<td>Continue 250mL/hr for ‘hour 4’</td>
<td>Continue insulin at variable rate to maintain BGL 9-14mmol/L. It is likely that the rate will need to be decreased at this point to maintain 9-14mmol/L</td>
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<tr>
<td>Maintain airway - consider NGT if protracted vomiting/risk of aspiration</td>
<td></td>
<td>Continue insulin at variable rate to maintain BGL 9-14mmol/L. It is likely that the rate will need to be decreased at this point to maintain 9-14mmol/L</td>
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<tr>
<td>Check βHCG and cardiac enzymes if indicated</td>
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<td>Give K+ infusion OVER ONE HOUR via “Y” site if serum K+ &gt; 5mmol/L or patient anuric - withhold</td>
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<tr>
<td>Undertake septic screen and treat infection appropriately if present</td>
<td>If serum K+ &gt; 3.5 – 5mmol/L, give 10mmol/100mL</td>
<td>If serum K+ &gt; 3.5mmol/L, give 2 x 10mmol/100mL</td>
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<tr>
<td>Fluid balance chart and neurological observations</td>
<td>If K+ &lt; 3.5mmol/L, give 10mmol/100mL</td>
<td>Ensure patient has a formal clinic appointment</td>
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<tr>
<td>If patient is using a continuous subcutaneous insulin infusion (CSII) pump - remove it</td>
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<td>Arrange appropriate follow up/contact with diabetes educator and dietitian within one week of discharge</td>
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<tr>
<td>Consider whether cardiac monitoring is required</td>
<td>Continue initial rate of insulin if BGLs are decreasing (if &gt;14 mmol/L initially) and venous pH at ‘hour 2’ and ‘hour 4’ is consistently increasing (finger pricking ketones at ‘hour 4’ should be decreasing)</td>
<td>Consider the need for a referral to the mental health team if more than one DKA admission in 12 months</td>
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<tr>
<td>DVT prophylaxis</td>
<td>Increase rate of insulin if venous pH is not increasing at ‘hour 2’ and ‘hour 4’ or if BGLs rise or do not decrease (if &gt; 14mmol/L)</td>
<td>Ensure patient has a formal clinic appointment</td>
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</tr>
<tr>
<td>Prescribe/administer patient’s usual long acting insulin</td>
<td>When BGL &lt; 14mmol/L give 10% glucose 100mL/hr via “Y” site (cannula 2) and review insulin infusion rate to maintain BGL 9-14mmol/L. Continue 0.9% sodium chloride fluid resuscitation as above</td>
<td>Ensure that a copy of patient discharge letter is sent to patient’s GP and diabetes care team</td>
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<tr>
<td>Step 5 – contact accepting consultant</td>
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<td>Refer to supplementary notes for further information</td>
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<td>Contact consultant: Time: …………………</td>
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<td>Accepting consultant: Dr ………………………</td>
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</table>

This protocol identifies the key steps of management for diabetic ketoacidosis (DKA) as per the Queensland Government managed care guidelines. It provides a structured approach to patient care, focusing on initial investigations, fluid replacement, insulin administration, electrolyte management, and potassium replacement.

Note: This protocol is intended for use in hospitals and primary care settings and should be adapted to local circumstances and patient needs.
**Management of diabetic ketoacidosis in adults (age 16 years and over)**

This clinical protocol is a general guide and does not replace clinical judgement.

Care should be individualised to meet the specific needs of each patient.

Flowchart to be completed by medical officer.

<table>
<thead>
<tr>
<th>Date:</th>
<th></th>
<th>Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hour</td>
<td>0</td>
<td>1</td>
</tr>
</tbody>
</table>

**Finger prick**

- BGL
- Ketones

**Chemistry**

- Serum glucose
- Serum sodium
- Serum potassium
- Serum chloride
- Serum bicarbonate
- Urea
- Creatinine

**Effective osmolality**

**Anion gap**

**Blood gases**

- pH: specify venous (V) or arterial (A)
- pO₂
- pCO₂
- SaO₂

**Fluid/Metabolites (ml/hr)**

- 10% glucose
- 0.9% normal saline

**Legend**

Φ Effective osmolality = 2x Na (mmol/L) + glucose (mmol/L)
Step 1 - initial investigations

Guidance on ketones:
Capillary finger prick ketones testing is essential for diagnosis of DKA and can indicate effective management.
Urine ketones are not used to monitor DKA.
Monitor capillary finger prick ketones regularly until ketone free. Decreasing finger prick ketones can be used as a surrogate for improving acidosis.

Step 2 - fluid replacement

Avoid using 0.45% sodium chloride as there is no evidence to suggest that this is of benefit in the management of DKA. The suggested fluid resuscitation will meet the needs of people within the 50 – 90kg range. Fluids will need to be carefully reviewed and possibly modified if outside this weight range.

Use of large volumes of 0.9% sodium chloride can lead to hyperchloremic acidosis. The aim is to maintain the glucose between 8.3–11.1 mmol/L or less and the anion gap normal.

Step 3 - start intravenous insulin

Document in special instructions section of the IV insulin order form that the patient is on DKA protocol. Use any soluble insulin eg: Actrapid, Humulin R. Concentration should be 50 units of insulin in 49.5mL 0.9% sodium chloride through a syringe driver.

Step 4 - Continuation of intravenous insulin

Long acting (basal) subcutaneous insulin can be introduced in combination with intravenous insulin. There is no need to stop long acting insulin in patients already on it.

Other notes

Guidance on bicarbonate:
There is no evidence to support the use of HCO₃⁻ unless there is evidence of cardiogenic shock or other lactic acid-generating conditions with markedly low pH < 6.9. Must be given with consultant authority.

Guidance on phosphate:
There is no evidence to support the use of phosphate replacement unless severe hypophosphatemia (< 0.4mmol/L). Must be given with consultant authority.

Hypoglycaemia:
The blood glucose may fall very rapidly as ketoacidosis improves. Hypoglycaemia may result in rebound ketosis driven by counter-regulatory hormones. Once the blood glucose falls to 14 mmol/L, intravenous glucose 10% should be commenced to allow continuation of the insulin infusion to correct the acidosis. The patient will require contemporaneous fluid resuscitation with 0.9% sodium chloride.

Step 5 - transition to subcutaneous insulin

Long acting/basal subcutaneous insulin needs to be commenced at least 2 hours prior to ceasing the intravenous insulin. If the patient’s usual long acting subcutaneous insulin was continued through the admission as advised in immediate management, the intravenous insulin can be stopped as soon as the other criteria are met, which may reduce the length of stay.

If the patient was diagnosed with diabetes this admission, an insulin regimen will need to be developed.

Consider precipitating factors

Common causes include:
• Omission of insulin
• Infection
• Newly diagnosed diabetes mellitus
• Myocardial infarction
• Combination of the above

Ongoing management

Step 3 - potassium replacement

Potassium should not be administered at a rate greater than 20mmol/hr except in the first 4 hours (maximum 40mmol/hr) without consultant authority.

Step 4 - intravenous insulin and glucose

Glucose should be introduced in conjunction with 0.9% sodium chloride. Evidence for using 10% glucose is lacking and mainly anecdotal. However, at this concentration, higher insulin levels can be maintained with enhanced clearance of ketones and resolution of acidosis. It is not meant for re-hydration but glucose control.

While there is no specific evidence suggesting avoiding a rate of drop of BGL of 5mmol/L/hr, there may be an increased risk of cerebral oedema if BGLs drop too quickly. The aim is to maintain the glucose between 9-14 mmol/L until ketones are negative or the infusion is stopped. If the BGL is < 9 mmol/L, the infusion rate of glucose should therefore be increased.

Avoid hypoglycaemia as this can cause rebound ketosis.

Subsequent management

Step 5 - transition to subcutaneous insulin

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Discharge planning

Step 1 - Refer for specialist review before discharge

Diabetes specialist review team should include:
• Diabetes educator
• Dietitian
• Physician specialising in diabetes
• Psychologist

Problems contributing to DKA episode:
• Errors in insulin administration
• Faulty equipment
• Practical problems
• Psycho-social issues requiring psychological support (especially recurrent DKA)

Diabetes education:
Some or all of the following aspects should be considered and discussed between the diabetes educator/dietitian and patient:
• Patient knowledge and understanding of the condition
• Respiratory rate > 20/min
• Heart rate > 100/min or less than 50/min
• Systolic BP less than 100mmHg
• Circulatory compromise: pale, sweaty, cool or clammy peripheries – mottling indicates severe circulatory compromise (do not use a point of care BGL meter in this case)
• Temperature > 38°C or less than 36°C
• Altered level of consciousness
• Anaemia
• Anion gap > 16, pH < 7.1, bicarbonate < 10mmol/L

References:


The Statewide Diabetes Clinical Network would like to acknowledge Dr Kunwarjit Sangla and the Townsville HHS for their assistance in developing this protocol.

If you have any questions or feedback about this document please contact the Statewide Diabetes Clinical Network Coordinator on Statewide_Diabetes_Network@health.qld.gov.au